Air Pollution Control
The Tree Factor

Green Makeover
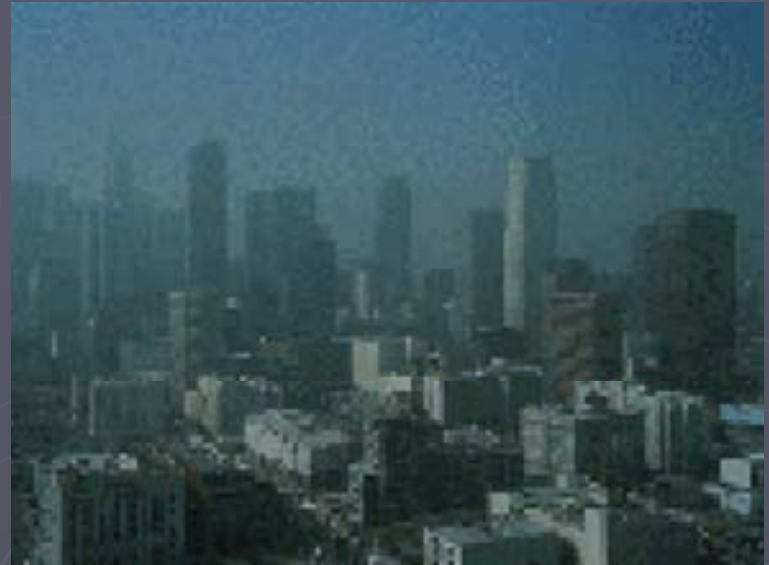### October 19, 2005

Jim Geiger
Center for Urban Forest Research

Today

► Air pollutants – impacts on society

► Green cleans

► How do trees do what they do?

► Unlocking the mystery of deposition

► The tree opportunity

Air Pollutants
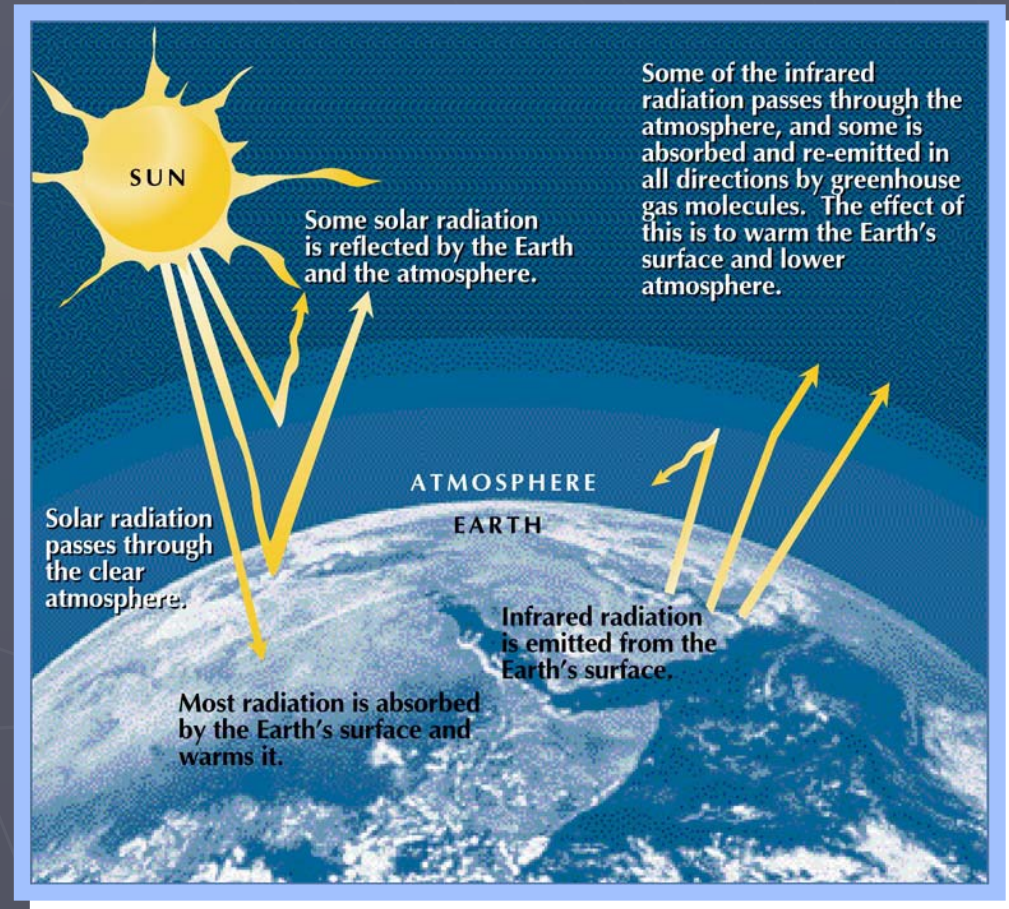
CO_2

Ground level Ozone (SMOG)

Particulates

CO_2

EPA now views CO_2 as a pollution concern.

Traps earth's heat and contributes to global warming.

Human-produced greenhouse gases exceed the balancing effects of natural sinks.
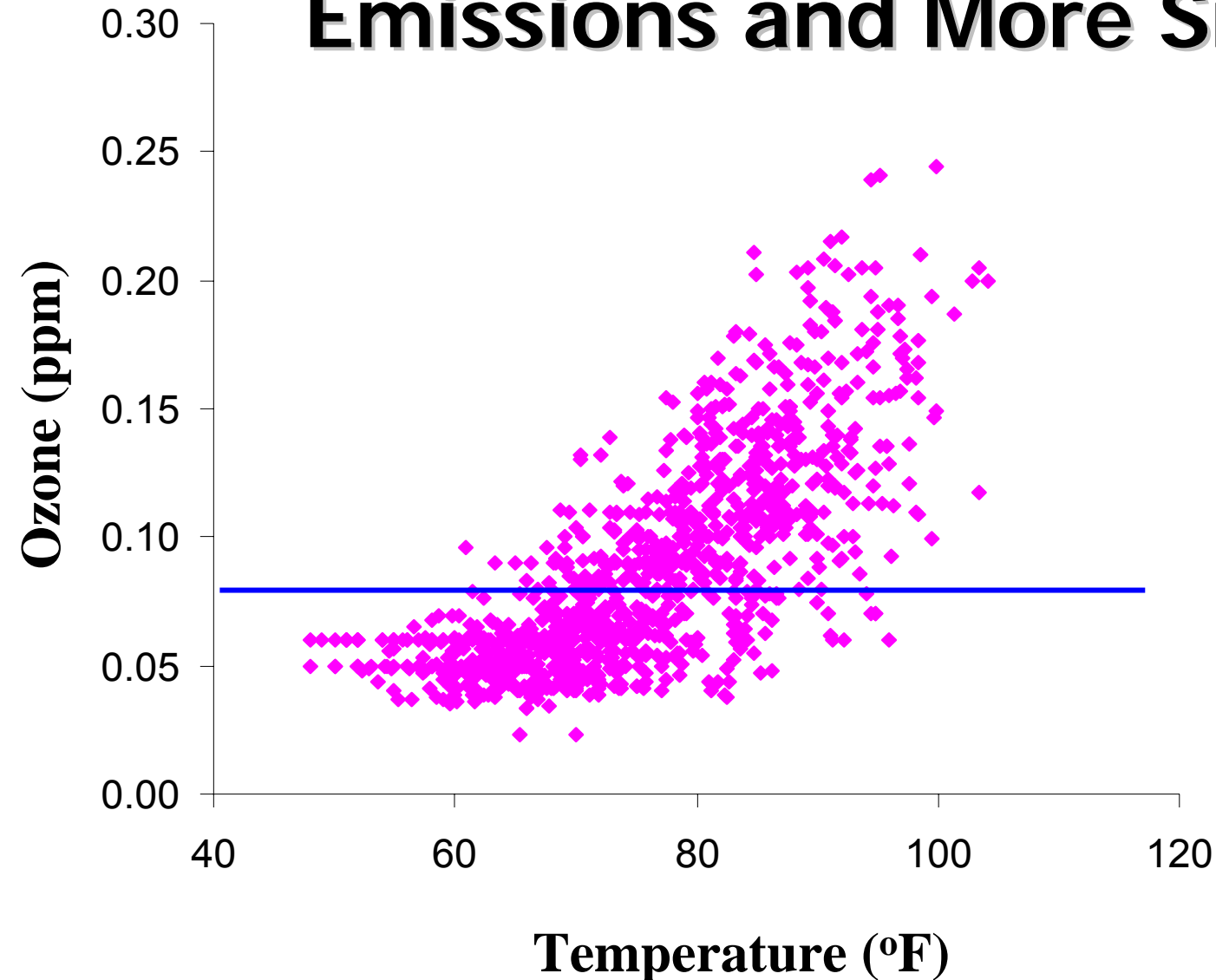

SUN

Some solar radiation is reflected by the Earth and the atmosphere.

Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and lower atmosphere.

Solar radiation passes through the clear atmosphere.

ATMOSPHERE

EARTH

Infrared radiation is emitted from the Earth's surface.

Most radiation is absorbed by the Earth's surface and warms it.

GL Ozone or SMOG

Chemical reaction between NO_x and VOCs in presence of sunlight.

Emissions from industries, utilities, exhaust, gasoline vapors, solvents.

Hotter Days Lead to Higher Emissions and More Smog

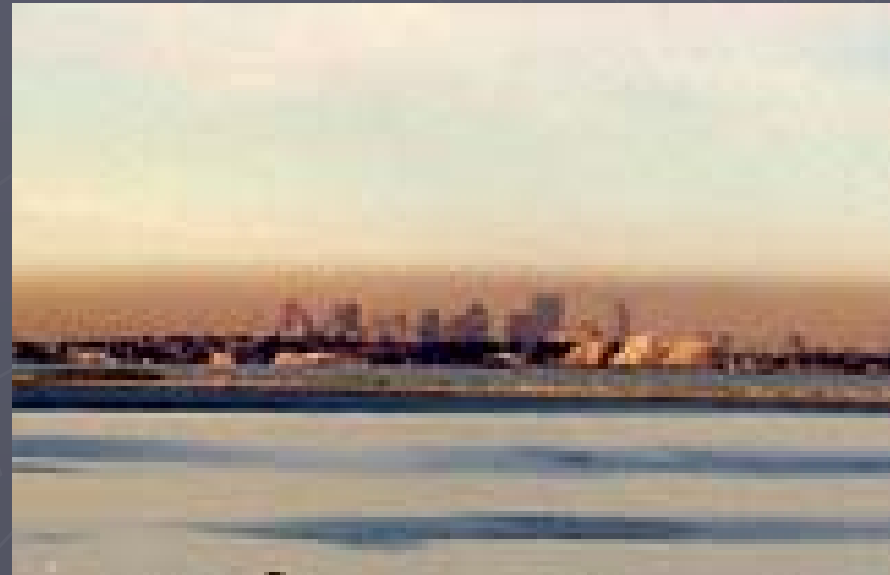Ozone (ppm) vs. Temperature (°F) scatter plot

Particulates

Micrometers

PM_{40} coarse – dust, dirt, soot, smoke.

PM_{10} EPA regulates, "inhalables."

$PM_{2.5}$ fine – hundreds of different chemicals.

$PM_{0.1}$ ultra fine.

Impacts on Society

Energy

Transportation

► Half of all people live in areas that do not meet national standards.

► 69% power plants use fossil fuel. Nearly 50% coal.

► Account for 66% sulfur dioxide emissions, 22 % of nitrogen oxide pollution.

► 30,000 premature deaths annually, 603,000 asthma attacks

► The miles/gal rating 39% better in last 10 years.

► But fuel consumption has increased by 19%.

► Vehicles contribute 60-70% of urban air pollution.

► Automobiles highly inefficient – only 13% of energy used for propulsion.

► Housing, jobs, and shopping are increasingly separated.

► From 1983 to 1995, average length of work trips increased by 36%.

► One quarter of all trips are one mile or less, but three quarters of these trips are made by car.

► Infill instead of suburban development can lower vehicle miles by as much as 60%.

Green Cleans

Tree Power

- ► Bradford Pear
- ► 9 years old
- ► 9 inch dbh
- ► 28 ft. tall
- ► 19 ft. spread

- ► Number of leaves ?? (#)
- ► Total leaf area ?? (sq.ft.)

Tree Power

- ► Bradford Pear
- ► 9 years old
- ► 9 inch dbh
- ► 28 ft. tall
- ► 19 ft. spread

- ► Number of leaves 88,908
- ► Total leaf area 3846 sq ft

Trees. Important to Human Health.

► 1000 trees remove 530 tons of CO_2/year

► 1000 trees remove 4,300 lbs of pollutants per year, including:

   720 lbs of ozone

   810 lbs of particulates

Trees. Avoid Powerplant Emissions

► Save 56% of annual air conditioning costs
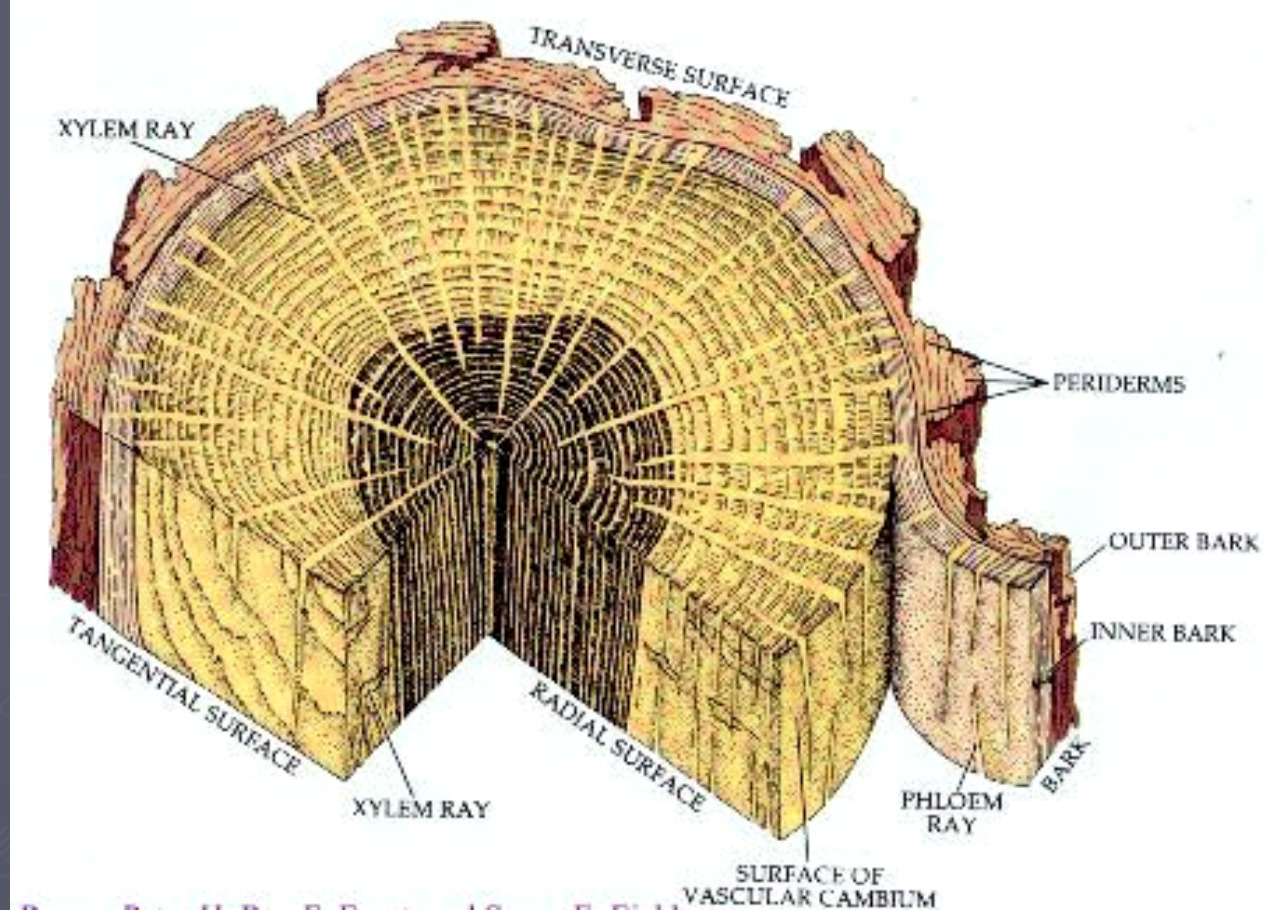► Save up to 25% of winter heating costs

Trees. Unexpected Benefit.

- ► Parking lots 3 degrees cooler
- ► Cabin 40-50^0
- ► Gas temp 4-8^0
- ► Reduce VOC 1ton/day w/50% shade

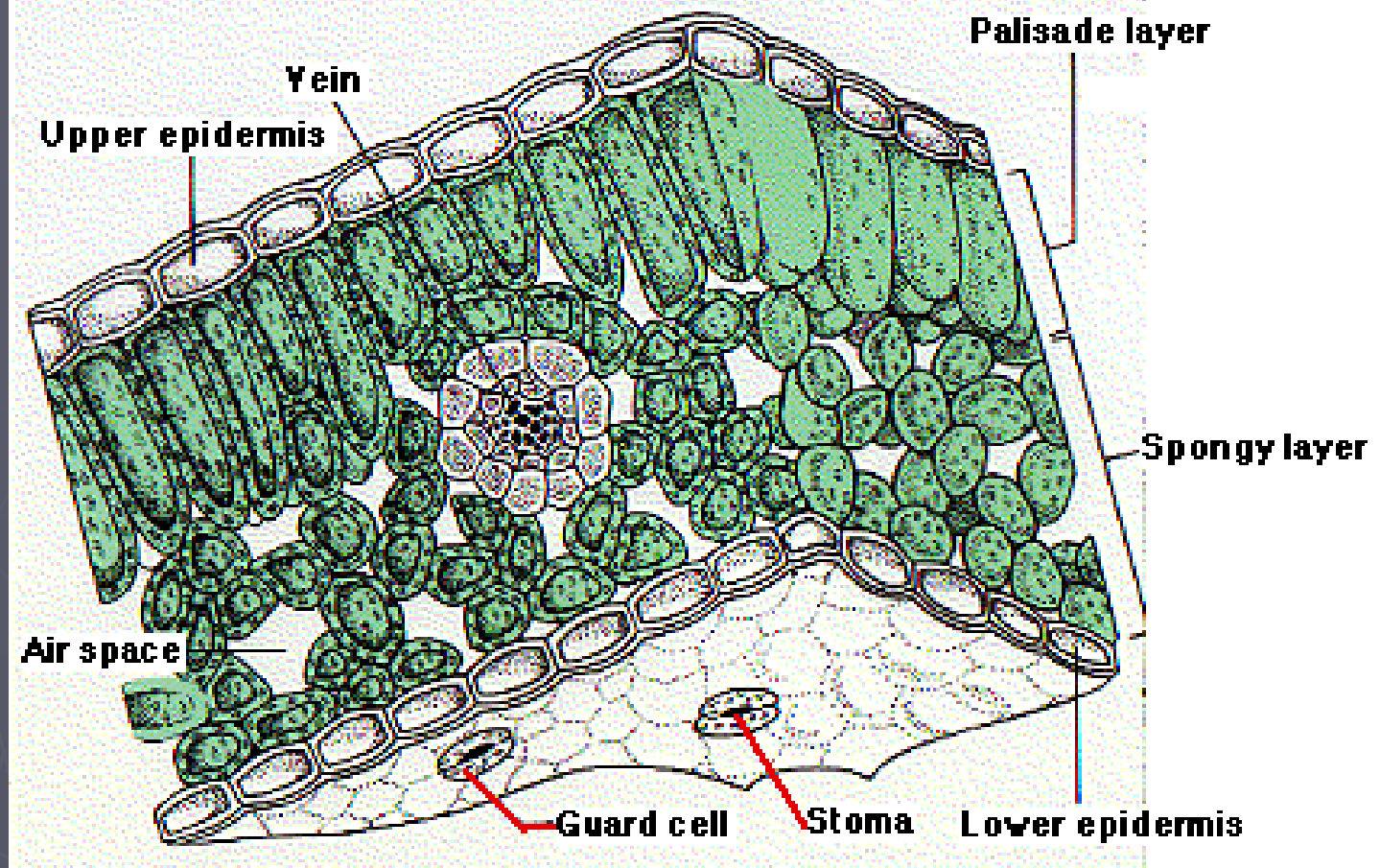# But Tree Care Practices Affect Tree Size, Growth, and Benefits

How Do Trees Do It?

Sequester CO_2 in woody tissue including roots.

Absorb gaseous pollutants through leaf stomata.

Bind or dissolve soluble pollutants onto leaf surfaces.

Intercept and store larger particles on outer leaf surface.

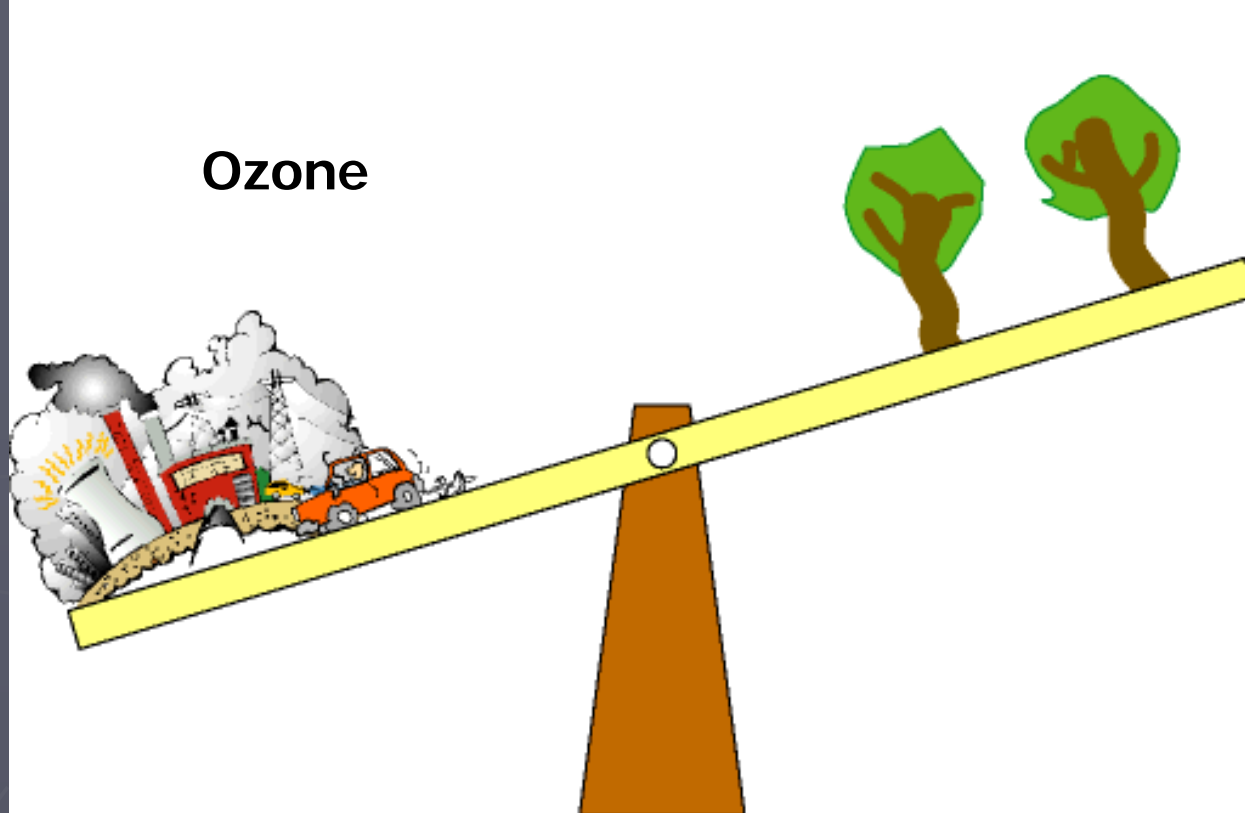Capture and store particles on uneven, rough bark surfaces.

Indirectly

► Transpiration and shading reduces heat island effect.

► Reduction in winter wind.

► Reduced demand for heating and cooling.

Unlocking the Mystery of Deposition

Ozone

► 11 Counties in Wisconsin designated nonattainment.

► 8-hour ozone standard may cause 11 more counties to be designated as nonattainment areas.

► Air pollution in Wisconsin has improved 38% since 1985 despite growth.....

► Drift from China and Mexico could reverse this positive trend.

Factors Affecting Uptake of Ozone and Particulates

► Concentrations of pollutants.
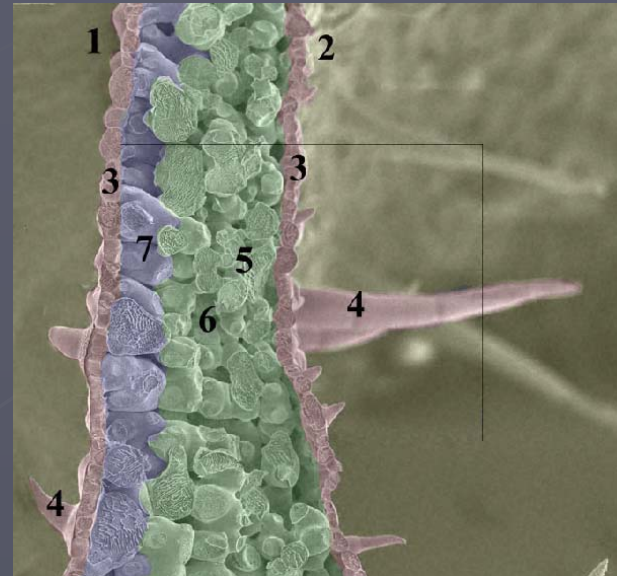
► Canopy cover, leaf surface area.

► "Surface roughness."

Sacramento Study Results

► 6,000,000 trees

► 335,000 tons net reduction of CO_2.

► 262,000 tons sequestered.

► 83,000 tons (25%) from shade.

► 10,000 tons released due to tree activities and decomposition

Results cont.

► Remove 1,600 tons of pollutants per year

► Most effective at removing ozone and particulates (PM_{10})

   - 665 tons of ozone
   - 748 tons of PM_{10}
   - 164 tons of NO_2
   - 30 tons of SO_2

Green Economics

What is the value of
this tree work for
6,000,000 trees?

► CO_2 reduction $3.3 million,
  $.55 per tree.

► O_3 and PM_{10} reduction is
  $28.7 million, $5 per tree.

Where do we go from here?

- ► 2% of total emitted.

- ► 98% is not being "treated" by trees.

- ► Opportunity??

The Tree Opportunity

New EPA Policy

<u>September 2004 Guidance Document</u>

▶ Incorporating Emerging and Voluntary Measures in a State Implementation Plan

▶ May include "strategic tree planting"

▶ Enforceable, quantifiable, permanent

United States
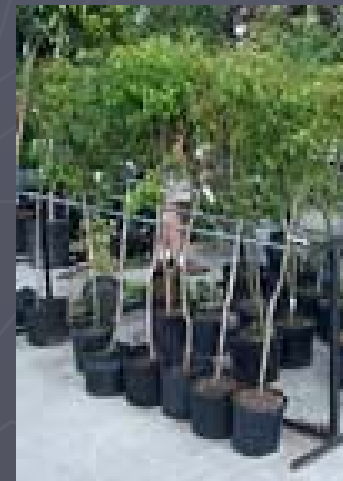Environmental Protection
Agency

Office of Air and Radiation

September 2004

INCORPORATING EMERGING AND
VOLUNTARY MEASURES IN A STATE
IMPLEMENTATION PLAN (SIP)

Emerging-measure

► Does not have the same high level of certainty as traditional measures – quantification purposes

► Provide flexibility in meeting SIP quantification requirements

► Some trees = BVOCs, but all trees reduce Ozone concentrations

► Tree strategies (tree planting, heat island reduction) should focus on reducing OZONE

► Small programs = small impact

Voluntary-measure

► Can choose, but not required.

► "Heat island programs to encourage activities that will reduce center-city temperatures during the summer, e.g. replacing roofs with Energy Star-labeled roof products or **planting shade trees**."

► State is still responsible for assuring that reductions credited in SIP occur.

EPA has raised limit for voluntary measures (e.g. trees) from 3% to 6% of the total amount of emissions reductions required for attainment.

Clear and convincing justification may move it higher.

Urban Forestry Options

► **New tree plantings** - enhance canopy cover.
Record new plantings in a regional database.

► **Landscape change** – preserve canopy cover.
If urban development projections are a 10% loss of canopy, then the goal is to maintain or increase canopy.
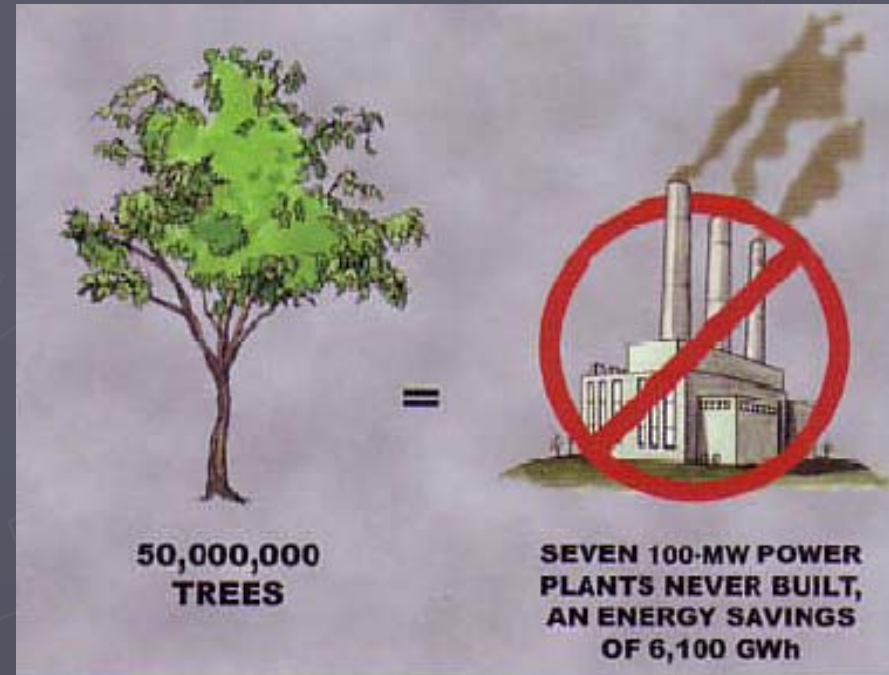
Double the Canopy

► Sacramento 6 county region

► 17% to 35%

► $100 million benefits/yr

► http://www.sactree.com

50 Million New Trees

- ► Strategic locations, 2 trees west and 1 east, in 15 yrs.

- ► Energy savings will double to 12,500 GWh/yr.

- ► 7 new power plants will not have to be built – 1.4 million homes, 3.5 million people.

- ► Another $1 billion saved in retail air conditioning costs.

- ► Peak load demand reduced by another 9% (19% total)

50,000,000 TREES = SEVEN 100-MW POWER PLANTS NEVER BUILT, AN ENERGY SAVINGS OF 6,100 GWh

One Air Pollution Solution

http://www.treescleanair.org/index.htm